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CAMBRIDGE
International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7998833087

BIOLOGY **9700/44**

Paper 4 A Level Structured Questions **May/June 2026**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 100.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **24** pages. Any blank pages are indicated.

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1 The bacterium *Escherichia coli* uses glucose as the main respiratory substrate, but other substances, such as lactose, can be used when necessary.

The enzyme β-galactosidase hydrolyses lactose to form glucose and galactose, which can then be used by *E. coli*.

Production of β-galactosidase in *E. coli* is regulated and involves a length of DNA known as the *lac* operon.

(a) Figure 1.1 is a simple diagram of the *lac* operon.

	P	O	*lacZ*	*lacY*	*lacA*	

Figure 1.1

When lactose is absent, a repressor molecule is attached to part of the *lac* operon.

Draw a cross (X) on Figure 1.1 to show the location where the repressor attaches to the *lac* operon when lactose is absent. [1]

(b) Structural genes *lacZ*, *lacY* and *lacA* are parts of the *lac* operon.

Complete Table 1.1 to:

- name the gene product of *lacY* and of *lacA*
- state the role of the gene product of *lacY*.

Table 1.1

structural gene	gene product	role of gene product
lacZ	β-galactosidase	hydrolyses lactose to form glucose and galactose
lacY	.....	....
lacA	.....	transfers an acetyl group from one molecule to another

[2]

(c) The enzyme β-galactosidase is an inducible enzyme.

Explain what is meant by an inducible enzyme.

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..... [1]

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(d) A scientist investigated population growth in *E. coli*.

- A sample of *E. coli* was removed from a liquid nutrient medium containing glucose.
- The sample was added to a liquid nutrient medium containing limited quantities of glucose and lactose.
- Estimates of the total number of cells in the sample (population size) were made at regular intervals.

Figure 1.2 shows the results of this investigation.

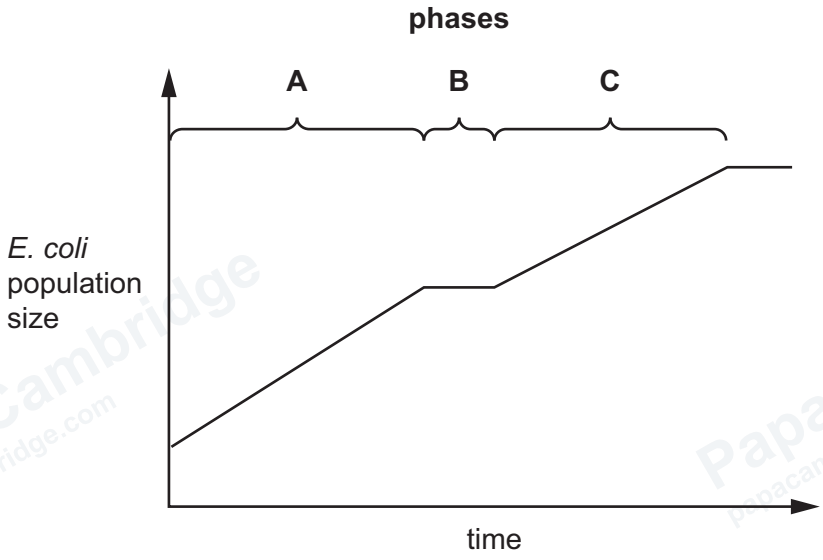


Figure 1.2

With reference to Figure 1.2, suggest explanations for phase **B** and phase **C**.

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2 **(a)** The movement of ions can result in different actions in plant cells and animal cells.

Table 2.1 lists several ions, the direction of movement of each ion and the cell type concerned, and the action that results from the movement of each ion.

Complete Table 2.1.

Table 2.1

ion	direction of movement of ion and type of cell	action that results from movement of ion
K^+	.....	opening of stomata
Na^+	into synaptic knob of presynaptic neurone	.....
Ca^{2+}	into synaptic knob of presynaptic neurone	.....
.....	from sarcoplasmic reticulum to sarcoplasm of cell of striated muscle	binding to troponin

[4]

(b) In the nephron of the kidney, selective reabsorption occurs in the cells of the proximal convoluted tubule. Sodium ions are actively transported out of these cells into the surrounding tissue fluid and pass into the blood.

Outline how the active transport of sodium ions out of the proximal convoluted tubule cells results in the absence of glucose in urine.

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3 The tuatara, *Sphenodon punctatus*, is a reptile that is native to New Zealand and is found in the wild only in that country. Fossil evidence shows that there has been little morphological change in the tuatara over the last 200 million years.

Figure 3.1 shows a tuatara.



Figure 3.1

(a) The tuatara inhabited the main islands and the smaller islands of New Zealand for most of the last 200 million years. Around 800 years ago, humans arrived in New Zealand. In the last hundred years, a rapid decrease in the number of tuatara has occurred and now they are found in the wild on only 32 small islands.

Suggest why the number of tuatara has decreased in most parts of New Zealand.

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(b) Moutoki Island is one of the small islands where there is a wild population of tuatara. The size of the population of tuatara was estimated using the mark–release–recapture method:

- A sample of 23 tuatara was captured using a humane (harmless) trap.
- The tuatara were marked in a way that did not harm them.
- The marked tuatara were released into the area where they were captured.
- A period of time was allowed for the marked tuatara to mix into the population.
- A second sample of 38 tuatara was captured, in which 6 individuals were marked.

Use the Lincoln Index to calculate the size of the tuatara population on Moutoki Island.

Give your answer to the nearest whole number.

Lincoln Index

$$N = \frac{n_1 \times n_2}{m_2}$$

Key to symbols:
N = estimate of population size
n_1 = number of individuals captured in first sample
n_2 = number of individuals (both marked and unmarked) captured in second sample
m_2 = number of marked individuals recaptured in second sample

..... [2]

(c) The optimum body temperature for the tuatara is 16–21 °C, the lowest of any reptile. The low body temperature results in a slow metabolism and therefore slow rate of respiration.

Suggest **and** explain why a low body temperature would result in a slow rate of respiration.

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(d) The tuatara belongs to the kingdom Animalia.

Outline the main characteristics of the kingdom Animalia.

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[Total: 13]

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4 **(a)** Twenty million years ago there was an ocean between the continents of North America and South America. The snapping shrimp, *Alpheus sp.*, lived in this ocean.

Figure 4.1 shows a snapping shrimp.



Figure 4.1

About 3 million years ago, volcanic activity and sedimentation formed a narrow strip of land, Panama, joining North America and South America.

Figure 4.2 shows the area 20 million years ago and now.

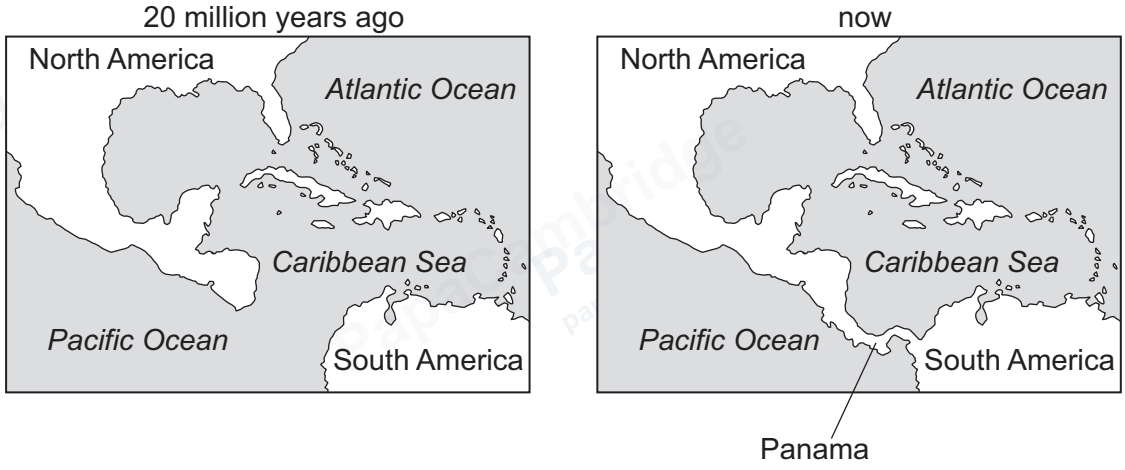


Figure 4.2

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Snapping shrimp living in the Caribbean Sea near Panama look similar to snapping shrimp living in the Pacific Ocean near Panama. However, if they are paired together, they do not mate.

Explain how, over time, the snapping shrimp living in the Caribbean Sea and the snapping shrimp living in the Pacific Ocean developed so that they now do **not** mate with each other.

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(b) Define the terms ecosystem and niche.

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5 **(a)** Insulin has an important role in the maintenance of blood glucose concentration.

An investigation measured how blood glucose concentration and blood insulin concentration changed after a person had eaten a glucose-rich meal.

The results are shown in Figure 5.1.

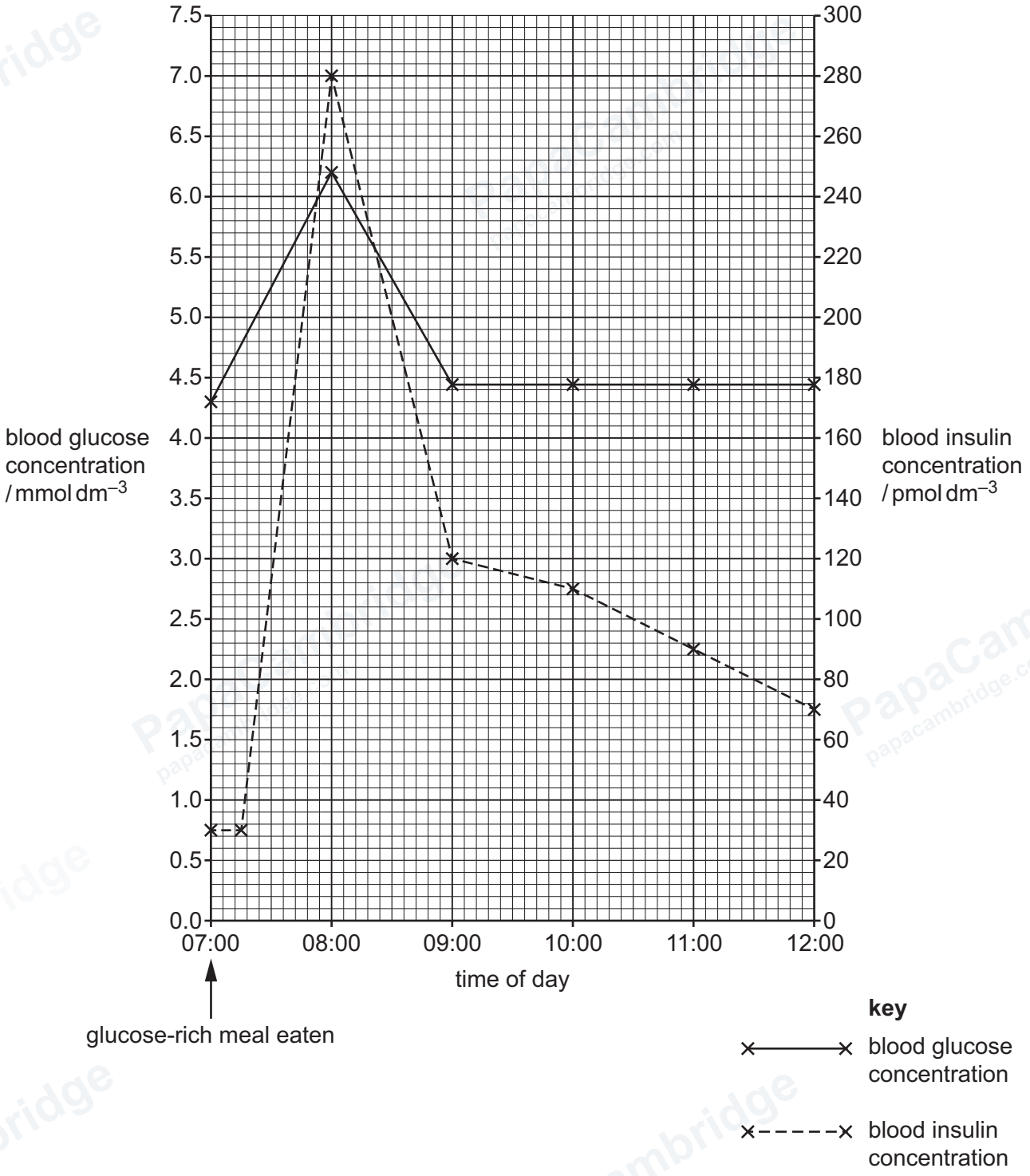


Figure 5.1

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(i) Use Figure 5.1 to calculate the percentage increase in the blood **insulin** concentration between 07:00 and 08:00.

Give your answer to **four** significant figures.

..... % [2]

(ii) With reference to Figure 5.1, explain the change that occurs in the blood glucose concentration between 08:00 and 09:00.

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(b) Type 1 diabetes in humans is a condition in which the pancreas does not produce enough insulin to control blood glucose concentration. People with type 1 diabetes measure their blood glucose concentration at regular intervals using either a biosensor or test strips.

(i) Name the **two** enzymes that can be used in biosensors and test strips to measure blood glucose concentration.

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(ii) People with type 1 diabetes need daily injections of insulin. Insulin used to be obtained by extracting it from farm animals. Now it is made artificially using genetic technology and has the same amino acid sequence as human insulin.

Explain the advantages of producing insulin, with the same amino acid sequence as human insulin, by genetic technology rather than obtaining it from farm animals.

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6 **(a)** Figure 6.1 shows a transmission electron micrograph of part of a chloroplast of Timothy grass, *Phleum pratense*.

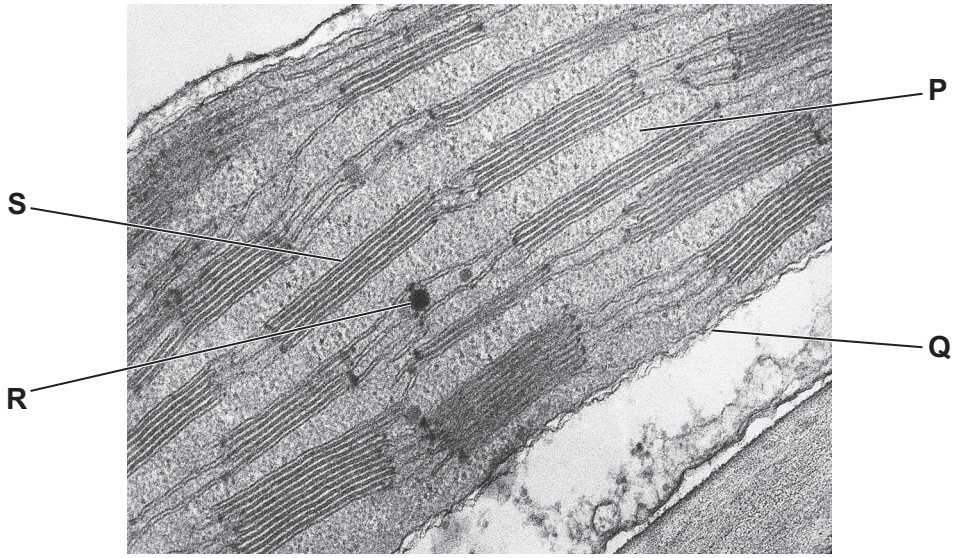


Figure 6.1

State the letter **P**, **Q**, **R** or **S** from Figure 6.1 that identifies:

- a structure containing photosynthetic pigments .....
- an area where the light-independent stage of photosynthesis is carried out .....

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(b) A student carried out an experiment to investigate the effect of light intensity on the rate of photosynthesis in the brown alga *Fucus serratus*. Brown algae are aquatic multicellular protoctists.

- Discs were cut from the photosynthetic tissue of *F. serratus*.
- Ten discs were added to each of four beakers containing 50 cm^3 of sea water.
- The beakers were illuminated with identical LED lamps placed at different distances (d), in centimetres, from the beakers.
- The relative light intensity was determined by calculating $1 / d^2$.
- When the discs, which were denser than sea water, had sunk to the bottom of the beakers, the student started a timer.
- The student observed the discs rising to the surface of the water in the beakers and recorded the time taken (t), in minutes, for the fifth disc from each beaker to reach the surface.
- The rate of photosynthesis was determined by calculating $1000 / t$.

The results are shown in Table 6.1.

Table 6.1

distance (d) of beaker from lamp / cm	relative light intensity	time (t) for fifth disc to reach the surface / min	rate of photosynthesis / min^{-1}
5	0.0400	.....	43.5
10	0.0100	36	27.8
15	.....	52	19.2
20	0.0025	88	11.4

(i) Complete Table 6.1 to show:

- the time for the fifth disc to reach the surface of the water in the beaker when the distance (d) between the beaker and lamp was 5 cm
- the relative light intensity ($1 / d^2$) when the distance between the beaker and lamp was 15 cm. [2]

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(ii) Use the data in Table 6.1 to:

- describe the relationship between light intensity and the rate of photosynthesis
- explain why the discs rose to the surface of the water in the beakers.

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(iii) The student found that there was no increase in the rate of photosynthesis when two identical lamps were placed 5 cm from the beaker.

Suggest why there was no increase in the rate of photosynthesis.

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7 Neurofibromatosis type 1 (NF1) is a genetically inherited autosomal condition in which tumours grow in the nervous tissue.

(a) If both parents of a child do **not** have NF1, then the chance that the child will have inherited NF1 is 0%.

In a family where one parent has NF1 and the other parent is unaffected, each child has a 50% chance of having NF1.

Using appropriate symbols, complete Figure 7.1 to show how there is a 50% chance of each child in this family having the condition.

symbols:		
parental phenotypes:	parent with NF1	unaffected parent
parental genotypes:		
gametes:		
offspring genotypes:		
offspring phenotypes:		

Figure 7.1

[4]

(b) Genetic screening during pregnancy can help identify the risk of a fetus having NF1. Screening tests can include blood tests, ultrasounds and other procedures.

Discuss the social and ethical considerations of using genetic screening for NF1.

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(c) One symptom of NF1, which can develop around the age of 20 years, is hearing loss caused by tumours of the auditory nerve. The auditory nerve contains sensory neurones that transmit impulses to the brain.

Suggest how a tumour on the auditory nerve could prevent the transmission of nerve impulses to the brain.

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8 The polymerase chain reaction (PCR) is an automated technique used in many applications of genetic technology. The main function of PCR is to amplify selected regions of DNA.

(a) Name the substances that are added to the PCR machine at the beginning of the process.

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(b) Describe **and** explain the steps involved in the PCR technique.

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9 **(a)** The Venus fly trap, *Dionaea muscipula*, is a carnivorous plant that captures small insects in a trap made from a specialised leaf.

(i) The first step in capturing an insect occurs when the insect touches at least two sensory hairs on the leaf of the plant within 35 seconds. The second step occurs when an action potential is produced and spreads over the leaf.

Outline how the stimulation of sensory hair cells of a Venus fly trap plant leads to an insect being trapped.

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(ii) A Venus fly trap can carry out photosynthesis.

Suggest why the Venus fly trap also captures and feeds on insects.

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(b) The nervous and endocrine systems of a mammal coordinate responses to changes in the internal and external environment.

Table 9.1 compares some features of the nervous and endocrine systems.

Complete Table 9.1.

Table 9.1

feature	nervous system	endocrine system
signal	impulse	.....
how signal is transmitted	.....	in blood
type of communication	electrical	.....
typical duration of effect	.....	.....

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10 (a) Glycolysis is a stage of respiration that occurs in the cytoplasm of eukaryotic cells.

Outline the glycolysis stage of respiration.

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(b) A group of drugs called statins are taken by many people to help lower the concentration of cholesterol in the blood. Sometimes statins can inhibit the production of coenzyme A.

Suggest the effects of a low concentration of coenzyme A on aerobic respiration.

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(c) Figure 10.1 shows part of a mitochondrion.

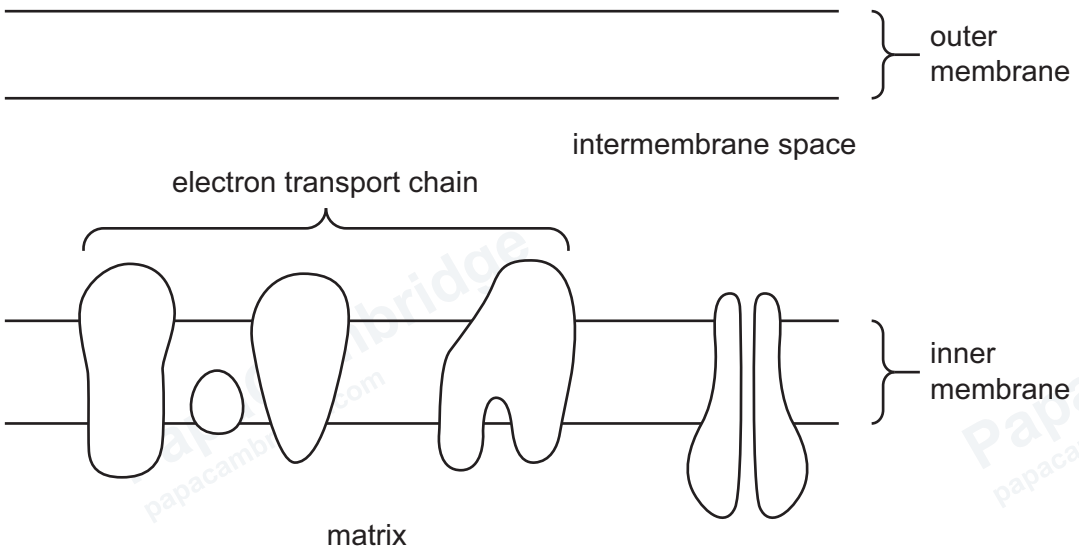


Figure 10.1

On Figure 10.1, use label lines and letters to label:

A – a structure that synthesises ATP

B – a structure that is impermeable to ions

C – an area that contains a high concentration of protons

D – a structure that receives hydrogen atoms from reduced NAD.

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